Original Article

Changing pattern of embryonic heart rate with gestation age: A marker of maturation of vagal activity

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ABSTRACT

Introduction: Early detection of a viable pregnancy can be done by transvaginal ultrasonography. Change in embryonic/fetal heart rate with gestational age is an interplay between increasing demand of fetus for nutrients and oxygen and vagal input to fetal heart.

Material and methods: Transvaginal ultrasonography was done on 109 pregnant women with gestational age ranging from 6 weeks to 10 weeks for gestational age and fetal heart rate. Statistical analysis of the data was done by Microsoft excel.

Observations and results: Mean embryonic/fetal heart rate was increased from 126.45±14.8 BPM from 6 weeks of gestation to 144.58±23.94 BPM at 9 weeks followed by a decline to 123.42 ±3.42 BPM at 10 weeks.

Conclusion: Decline in fetal heart rate followed by an initial rise in it with increasing gestational age can be a marker of fetal vagal activity.

INTRODUCTION

The cardiovascular system is the first system to function in the embryo.[1] Embryonic development of the fetal heart results from splanchnopleuric mesoderm that form a horseshoe shaped area in the anterior part of the embryonic disk which is a part of the secondary yolk sac wall. In this region two midline endothelial heart tubes form at 18 to 19 days after conception. These endothelial heart tubes fuse to form a single heart tube at about 22 days after conception; 5 weeks 1 day of pregnancy.[1]

The earliest proof of a viable pregnancy is obtained when cardiac activity of the embryo can be observed.[2] High-frequency vaginal transducers have improved embryonic imaging in early pregnancy and have facilitated the very early detection of cardiac activity.[3,4] Several investigators[5,6,7] have reported a gradual increase in embryonic heart rate as detected by ultrasonography starting in the fifth week of pregnancy followed by a decline in it. Studies have shown that the baseline fetal heart rates gradually decreased from 175 to 180 beats per minute(BPM) in the 9 to10 weeks of gestation to 140 to 145 BPM at 19 weeks of gestation, probably due to maturation of fetal vagal function.[8,9] Development of neural innervations of fetal heart begins in early embryonic life resulting in maturation of fetal vagal function.[1] The present study was done to determine the fetal heart rate variation in early pregnancy in Indian population as there is paucity of literature of similar study in Indian population

MATERIAL AND METHODS

The present study was a cross sectional descriptive and observational study involving the pregnant women attending the antenatal clinic in SMS Medical College and attached hospital over a period of 11 months. The study was started after obtaining approval from institutional scientific and ethics committee. Written informed consent was taken from all the pregnant females. Transvaginal ultrasonography scan was done on 109 pregnant women with gestational age ranging from 6 weeks to 10 weeks. All pregnant females with single embryo were included in this study. Pregnant women with multiple embryos were excluded from this study. Pregnant women with any medical illness were also excluded from this study. The scan was performed using Philips Affinity 70 G machine and fetal heart rate were recorded using M mode. Gestational age was assessed by measuring CRL in mm. Statistical analysis of embryonic heart rate with gestational age was done.

Statistical analysis

The data was analyzed by Microsoft excel software and mean standard deviation and range of fetal/embryonic heart rate was calculated of each weeks of gestational age of fetus.

RESULTS

In the present study, 109 pregnant women were included in the study. The number of pregnant women with 7 weeks, 8 weeks, 9 weeks and 10 weeks of gestation were 40(36.69%)), 24(22.01%), 24(22.01%) and 21(19.26%) (Table 1)

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Table 2 shows the mean standard deviation of embryonic/fetal heart rate as per their gestation age. The fetal heart rate increases steeply from 7 to 8 weeks, flattens from 8 to 9 weeks and declines afterwards.

Table: 1 Distribution of number of women as per gestational age of fetus

Gestation age	Number of women
6 weeks 4 days to 7 weeks to 3 days (7 weeks)	40(36.69%)
7 weeks 4 days to 8 weeks to 3 days (8 weeks)	24(22.01%)
8 weeks 4 days to 9 weeks to 3 days (9 weeks)	24(22.01%)
9 weeks 4 days to 10 weeks 3 days (10 weeks)	21(19.26%)

Table: 2 Distribution of gestation age with Fetal/Embryonic Heart rate

Gestation age	Mean(SD) of Fetal Heart rate	Range of Fetal Heart rate
7 weeks	126.45 (14.8) beats/min	105-160 beats/min
8 weeks	141.5 (20.41) beats/min	107-170 beats/min
9 weeks	144.58 (23.94) beats/min	104-170 beats/min
10 weeks	123.52 (3.42) beats/min	119-132 beats/min

DISCUSSION

Presence of fetal heart pulsations is a major sign of embryonic viability in the pregnancy.[9] Fetal heart rate measurement by M-Mode on ultrasonography is a routine established practice during antenatal checkup of a pregnant women. Fetal/embryonic heart rate varies with the gestational age of fetus and the reference values of normal range of fetal heart rate for different gestation age is present.[9] Fetal heart rate is determined by the changing circulatory demands of nutrients and oxygen in the developing fetus and the influence of the vagal activity on the fetal heart.[1,8] Maturation of the vagal activity due to myelination of vagal nerve act as a brake for increased fetal/embryonic heart rate during progression of gestation age of fetus.[10]

The present study shows a steep increase of embryonic/fetal heart rate from 7 to 8 weeks of gestation. From 8 to 9 weeks of gestation the slope of rise in heart rate flattens followed by a decline in heart rate from 9 to 10 weeks of gestation.

Our results are similar to observations of various previous studies. Stefos et al (1998) in their prospective study done on 2045 pregnant women showed a progressive increase in mean embryonic heart rate of 111±14 BPM at 6 weeks of gestation to 157±13 BPM at 9 weeks.[8] Tannirandorn et al (2000) in their study on Thai women found a progressive increase in mean embryonic heart rate from 124 BPM at 6 weeks to 177 BPM at 9 weeks of gestation. After 9 weeks it declines to 159 BPM at 12 weeks of gestation.[11] Hanprasertpong T et al (2006) in their study on 319 women observed an increase in embryonic heart from 6 to 8 weeks of gestation. After a maximum value at 8 weeks, the fetal heart rate declines to the lowest values at 14 weeks of gestation.[12] Tezuka et al (1991) in their study also observed an increase in mean embryonic heart rate from 97 BPM at 5 weeks to 174 BPM at 9 weeks followed by a decline.[13] Hertzberg et al (1998) showed an increase in embryonic heart rate from 6 to 8 weeks of gestation followed by a plateau in it at 9 weeks after that it followed a declining trend.[6] Hethyshi R et al in their study on Indian population also found a steady increase in fetal/embryonic heart rate from 6 to 10 weeks of gestation followed by a decline in it.[9]

From all these studies it is clear that the embryonic/ fetal heart rate increases from 6-10 weeks of gestation followed by a decline in it. The minor variations in the results may be due to difference in ethnicity of study population along with different methods of determining cut off values for gestation age. The decline in fetal heart from 9 to 11 weeks of gestation may be due to maturation of fetal cardiac vagal function due to myelination of vagal nerve. Gamble et al (1966) done an electron microscopic study on human fetus observed myelination of peripheral nerves from 12-22 weeks of gestation.[14]

CONCLUSION

The change in pattern of fetal heart rate with gestation age can be used as a measure of maturation of fetal vagal function.

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